



Assessing the Influence of Anthropogenic Factors on Water Quality: A Case Study of Ikpa River Basin, Akwa Ibom State

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Abstract

The aim of this study was to assess how anthropogenic activities have affected water quality in Ikpa River Basin. These activities have deteriorated the water quality extensively due to the substances released by the activities which include pH, Total dissolve solid (TDS), Hardness, Chloride, sulphate and lead, Nickel, Iron, E. coli, Total Coliform and Faecal Coliform. A combination of survey and laboratory analysis was used. Three (3) communities within the Ikpa river basin were purposively picked based on the high level of anthropogenic activities in these communities. The communities include Ntak Inyang, Ekpri Nsukara, Mbiakong with a sample size of 383. This study revealed that farming activities, sand mining, mechanic workshop, quarrying and palm oil processing are the most dominant anthropogenic activities around Ikpa River Basin. Total dissolve solid (TDS), pH, Hardness, Chloride, Nitrate, Sulphate and Lead are variables within the permissible WHO limit, while Nickel, Iron, E coli, Total Coliform and Faecal Coliform on Ikpa river are variables above the permissible limit. The study also revealed that farming activities, quarrying and sand mining significantly affect the water quality of Ikpa River Basin. Thus, the comparisons indicate that the surface and ground water from the locations are not safe for human consumption without extensive treatment. Hence, immediate intervention and appropriate water treatment measures are necessary to bring the water quality to acceptable WHO standards, particularly regarding heavy metals and microbial contamination.

Original Research Article

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1.0 Introduction

The global challenge of anthropogenic activities around river basins and its impact on surface water quality is a growing concern as urban population expands and industrial activity increases. It is generally accepted world over that rivers support millions of people who live along their banks and depend on them directly for irrigation, fishing, transportation of goods and services, provision of water for hydroelectric power production, industrial and domestic purposes, medicinal herbs, construction material, grazing and shelter (Lalika Makarius, Patrick Meire, Yonika Ngaga, 2015). In spite of these river values, there are still continuous ecosystem degradation and reduction around the basins that affect the water quality in Nigeria, Niger Delta and Akwa Ibom State specifically Ikpa River Basin . Some of these activities around the river basin are also alarming that they affect the water chemistry of river basins (Akpabio, 2007, 2004, 2010; Jimmy, 2025). So, in

the case of the Ikpa River Basin there has been much ecosystem degradation and reduction of its services.

More so, in spite of the different measures put in place to control the rate at which these anthropogenic activities affect our river water, yet the quality of water in our environment remain unsustainable. Unsustainable water managements has been the main reasons why we are suffering reduce water quality, water scarcity, depletion of ground water reserve and, negative impacts on ecosystems and communities. It practices can also have far-reaching and long-lasting impacts on the environment, economy and society. Pollution of surface and ground water, as a result of unsustainable water management has become a general problem in different parts of the world.

Monitoring of this water bodies are very essential because it forms the basic sources of drinking water for several

household and communities, especially for developing countries like Nigeria (Aralu *et al.*, 2021; Ajudi *et al.*, 2016; Akhigbe *et al.*, 2018). Thus, safe drinking water is a necessity for humans as well as other organisms. According to Khatri and Tyagi (2015) the availability of safe drinking water has improved in the last few decades but approximately about one billion people still do not have access to safe drinking water and another 2.5 billion do not also have adequate sanitation. However, it is estimated that by 2025 over half the world's population will be vulnerable to water shortages (Khatri & Tyagi, 2015). Water quality measured by assessing the physicochemical and biological properties of water against a set of standards, is used to determine whether water is suitable for consumption or safe for the environment. Some uses of water for domestic purposes, agricultural production, industrial production, mining, power generation and forestry practices, causes deterioration in water quality and quantity.

The groundwater or surface water quality is a function of natural influences and human activities either severally or collectively. Without human influences, water quality would be influenced only by the natural processes such as weathering of bedrock minerals, atmospheric processes (involving evapotranspiration, deposition of dust and salt by wind), natural leaching of organic matter and nutrients from soil, hydrological factors leading to run-off and biological processes in the aquatic environment that may bring about changes in the physical and chemical composition of water. Thus, water in the natural environment may contain dissolved substance as well as non-dissolved particulate matter (Hays & Thums, 2016)

It is worthy of note that anthropogenic factors affecting water quality in rural areas differ from those in urban areas. In rural areas they include agricultural practices like the use of fertilizers, herbicides and pesticides; river siltation due to erosion; nutrient loading in waters; run-off from degraded forest areas and animal husbandry. While anthropogenic factors that affect water quality in urban areas include industrialization, sewage discharge and other domestic activities. Changes in land use pattern including changes in land cover also adversely affect water flow and quality. In rural environments, especially in developing countries, the anthropogenic influences are less profound; those due to industrialization and commercialization may not be present at all. Thus, water pollutions due to industrial wastewater are absent in rural areas.

The quality of surface water and groundwater is a sensitive issue as far as health is concerned. Contamination of these resources should be prevented, controlled and reduced. Heavy metal contamination and contamination due to potassium ions, nitrates, phosphate, chloride and organic

solvents need to be removed. Faecal pollution also urgently needs to be addressed (Alam, Elahi & Alam, 2006). Anthropogenic factors affecting water quality causes elevated concentration of heavy metals, mercury, coliforms and nutrient loads. Thus, in this research study, the effects of natural processes, the human activities around the river basin, pollution due to environmental parameters such as heavy metals, bacterial and pathogenic contamination of Ikpa river water quality basically are studied in detail. On this note, to ensure the presence of long-term availability of good water quality and resource for future generation, which are the factors of sustainable water management, the anthropogenic activities affecting the water quality in Ikpa river basin must be traced and monitored.

The aim of the study is to assess how anthropogenic activities have affected water quality in Ikpa river basin, Akwa Ibom State, Nigeria. To achieve the above aim the following formed the objectives of the study.

- i. To identify the anthropogenic activities that are dominant within Ikpa river basin.
- ii. To assess the likely pollutants released by the anthropogenic activities.
- iii. To compare the quality of water with NESREA and WHO standards.

Materials and Methods

Study Area

The Ikpa River Basin is located between longitude 7°46' 34.9'' and 8°3' 11.9'', East of Greenwich Meridian and latitudes 5°0' 3.801'' and 5°16' 49.129'', the watershed covers an area of approximately 315.16 sq.km (Ekong, 2008). It is a major tributary of the Cross River Basin, which are bounded by latitudes 4°20N and 5°12N, and by longitude 7°31E and 8°11'E covering an area of about 413.5km² (Udosen & Inyang, 2001). There are also several linking tributaries subsisting enabling Ikpa River to take its course emptying into the Cross River estuaries starting from the Ediene through Itam, Ntak Inyang, Nduetong Oku, Ikot Anyang, Use Offot, Mbiakong, Itam beach and terminating at Nwaniba. Ikpa River Basin is situated about sixty kilometer (60 km) from the coast of the Atlantic Ocean. It is located approximately three kilometers (3 km) from Uyo central area and relatively positioned on a stretch of several communities spreading across four distinct local government of Akwa Ibom State which are Ibiono, Itu, Uruan and Uyo (Akwa Ibom State Government, 2012) However, Digital Elevation Model map (DEM) showing the location of the study area in the state and the settlement communities within the study area are shown Figure 1.1

Ikpa River Basin in Akwa Ibom State is known to be characterized by a complex geology due to its location within the Niger Delta region. It was stated that the area is underlain by sedimentary rocks formed during the Paleocene to Eocene periods and are mainly composed of sandstone, shale and limestone (Usoro, 1989). River basins are usually influenced by the presence of quaternary deposits such as alluvial fans, beach ridges and deltaic sediments which might also be deposited by the Ikpa River and its tributaries over time. Oil and gas exploration activities are likely to have caused a significant impact on the geology of the Ikpa River Basin, with seismic surveys and drilling operations revealing the presence of hydrocarbon reserves in the area. Thus, the geology of Ikpa River Basin is likely to be characterized by sedimentary rocks, quaternary deposits and the influence of oil and gas exploration activities. (Peter, 1989).

The drainage pattern of Ikpa River Basin is dendritic because of the relief nature of the state. This means that the tributaries of the river flow into the main trunk stream in a branching tree-like pattern and is common in areas where the underlying geology is relatively homogeneous and does not also control the direction of flow (Usoro, 1989). However, there are several linking tributaries subsisting, which might be enabling Ikpa river basin to take its course emptying into the Cross River Estuaries. Its start from Ediene in Ibiono through Itam, Ntak Inyang in Itu local government area, Nduetong Oku, Ikot Inyang, Use Offot, Ekpri Nsukkara in Uyo local government area, then Mbiabong, Ibiaku Uruan, Itam beach and terminating at Nwaniba. Thus, fig 1.2 is showing the drainage map of Ikpa River Basin.

Methods

This study adopted a cross-sectional survey design based on the objectives of the study. The approach includes the collection of water samples from the Ikpa River to the laboratory for physicochemical analysis as well as cross-sectional survey design of questionnaire for residents of the

study area to gather appropriate information from respondents. The research design involves a multi-disciplinary approach that combines fieldwork and data visualization to assess the impact of human activities on water quality in the Ikpa river basin.

The research also adopted both qualitative and quantitative techniques in order to provide a broader perspective to complement the strengths of a single design, address questions and theoretical perspective at different levels. Primary dataset for this objective was gathered from the Questionnaire from field survey. This data gave information on the different anthropogenic activities. Likely pollutants released by the anthropogenic activities dominant within Ikpa River basin was acquired from the water analysis at the Laboratory. Comparison of the water quality with NESREA and WHO standards. This data was a necessary requirement for this study in order to assess if the source of water available was up to the recommended quality standard.

From the study area population, three (3) communities within the Ikpa river basin were purposively picked based on the high level of anthropogenic activities in these communities. The communities include Ntak Inyang, Ekpri Nsukara, Mbiakong. A sample size of 383 was derived. The data were quantified using tables and analysed using Microsoft Excel 2010. This information helped identify potential sources of pollution in the river basin.

Laboratory analysis, such as water analysis was used to assess the water quality in the Ikpa river basin. Parameter such as pH, Total Dissolved Solids (TDS), Nutrients, heavy metals, and microbial pollutants were measured in the laboratory to determine the extent of pollution in the river. Again, geographic positioning system (GPS) was used to establish the coordinates of the sampling points and a relief map of the area was produced to show the terrain of the location for the visual understanding of the sample sites.

4.0 Results and Findings

Table 1 Age of Respondents

Location	No.of Respondent	BELOW30	31-45	46-60	ABOVE 60	Relative Frequency of Respondent	Relative Percentage of frequency of Respondent(%)
Mbiakong	29	4	12	13	8	0.077	7.7
	30	6	14	7	5	0.08	8.0
	30	8	9	7	6	0.08	8.0
	29	7	9	8	8	0.077	7.7
Ntak Inyang	30	7	4	5	9	0.08	8.0
	31	2	9	13	7	0.083	8.3
	31	4	7	14	8	0.083	8.3
	31	4	11	11	5	0.083	8.3
Ekpri Nsukara	33	7	11	8	7	0.088	8.8
	33	7	13	8	5	0.088	8.8
	34	8	11	7	8	0.091	9.1
	34	8	7	6	3	0.091	9.1

Total	375	72	117	107	79
Percentage (%)		19.20	31.20	28.53	21.07

Table 2: Occupation of the respondent

Location	No. of Respondents	Farming	Sand mining	Mechanic Workshop	Palm oil Processing	Quarrying	Civil Service
Mbiakong	29	6	3	4	5	3	8
	30	9	5	4	5	4	3
	30	7	3	6	7	5	2
	29	11	2	3	6	5	2
Ntak Inyang	30	11	6	3	5	3	6
	31	7	4	4	4	7	5
	31	9	3	5	4	4	6
	31	8	6	6	3	4	4
Ekpri Nsukara	33	7	4	4	4	7	6
	33	1	6	7	4	3	9
	34	9	6	5	4	3	7
	34	5	4	6	6	5	8
Total	375	90	52	57	57	53	66
Percentage (%)		24.00	13.87	15.20	15.20	14.13	17.60

Source: Researcher's construct from field survey (2025)

The study surveyed a total of 375 respondents across the study area, examining their occupations. In Source: Field survey (2025) Mbiakong, out of 29 respondents, 6 were engaged in farming, 3 in sand mining, 4 in mechanic workshops, 5 in palm oil processing, 3 in quarrying, and 8 in civil service. In Ntak Inyang, among 31 respondents, 7 were farmers, 4 were sand miners, 4 worked in mechanic workshops, 4 processed palm oil, 7 were involved in quarrying, and 5 were in civil service. In Ekpri Nsukara, out of 33 respondents, 1 was a farmer, 6 were sand miners, 7 worked in mechanic workshops, 4 processed palm oil, 3 were in quarrying, and 9 were in civil service. In general, farming was the most common occupation, with 90 respondents (24.00%), followed by civil service with 66 respondents (17.60%), mechanic workshops and palm oil processing each with 57 respondents (15.20%), quarrying with 53 respondents (14.13%), and sand mining with 52 respondents (13.87%).

Another study also considered the monthly income of the respondents which is shown in table 4.8 where 20.00% of the respondents earned below N30,000, 22.93% earned between N30,000- ₦50,000, 18.40% earned between ₦51,000- ₦70,000, 23.20% earned between ₦71,000- ₦100,000 and 15.47% earned above ₦100,000. This describes the economic wellbeing of the respondents; that most of the respondents earned between ₦71,000- ₦100,000 as monthly income.

4.1.2: Anthropogenic Activities Dominant in the Ikpa River Basin.

Based on the questionnaire survey, Table 4.9 describes the predominant anthropogenic activities of respondents within the Ikpa River basin, several dominant anthropogenic activities were identified.

Table 3: Anthropogenic activities dominant in the study area

LOCATION	NO. OF QUESTIONNAIRE	Farming	Sand mining	Mechanic Workshop	Quarrying	Palm oil Processing
NTAK INYANG 1	29	14	3	4	3	5
NTAK INYANG 2	30	12	5	4	4	5
NTAK INYANG 3	30	9	3	6	5	7
NTAK INYANG 4	29	11	4	3	5	6

MBIAKONG 1	30	13	6	3	3	5
MBIAKONG 2	31	12	4	4	7	4
MBIAKONG 3	31	15	3	5	4	4
MBIAKONG 4	31	12	6	6	4	3
EKPRI NSUKARA 1	33	12	6	4	7	4
EKPRI NSUKARA 2	33	10	6	5	8	4
EKPRI NSUKARA 3	34	10	8	5	7	4
EKPRI NSUKARA 4	34	10	7	6	5	6
TOTAL	375	140	61	55	62	57
Percentage (%)		37.33	16.27	14.67	16.53	15.20

Source: Researcher's Construct from field survey.

Farming which had 140 individuals representing 37.33% of the surveyed population, stands out as the most prevalent activity. This suggests significant agricultural practices within the basin, potentially impacting water quality through fertilizer and pesticide runoff, as well as land use changes leading to erosion and sedimentation.



Figure4.1: Farming activities in the river basin

Source: Field survey (2025)

Quarrying: Following farming, had 62 respondents (16.53%). It also represents a significant extractive industry within the basin. Quarrying operations which involve the removal of large amounts of rock and soil, which can contribute to sedimentation, habitat loss, and potential contamination of water sources through dust and chemical runoff.



Figure 4.2 Quarrying activities in the study area

Source: Field survey (2025)

Sand mining: This involved 61 respondents (16.27%), indicating substantial extraction of sand resources from the river or its surroundings. This activity can lead to riverbed degradation, altered flow patterns, increased turbidity, and habitat destruction directly affecting the aquatic ecosystem.



Figure 4.3: Sand mining activities in the study area

Source: Field survey (2025)



Figure 4.4: Sand mining activities in the study area

Source: Field survey (2025)

Palm oil processing, involving 57 respondents (15.2%), indicates agro-industrial activity within the area. Palm oil processing can generate significant wastewater containing organic matter and nutrients, which, if not properly managed, can lead to water pollution and oxygen depletion in the Ikpa River.



Figure 4.5: Palm oil proceeds (palm kernel shells)

Source: Researcher's field survey (2025)

Mechanic workshops, with 55 respondents (14.67%), suggest the presence of automotive repairs and maintenance activities. These can introduce pollutants like oil, grease, heavy metals, and solvents into the environment, potentially contaminating surface and groundwater within the river basin.

Finally, from the table the dominant anthropogenic activities within the Ikpa River basin, as indicated by the table are agriculture (farming), resource extraction (sand mining and quarrying), and industrial/commercial activities (mechanic workshops and palm oil processing). Each of these activities carries specific potential environmental impacts that need to be further investigated to understand their cumulative effect on the Ikpa River ecosystem.

Table 4: Laboratory Result showing Pollutant level at Different Locations and Water types

LOCATION	NO. OF QUESTIONNAIRE	NO NOTICEABLE CHANGE	OCCASSIONALLY SMELLS CLEANER	OCCASSIONALLY SMELL STAGNANT	OCCASSIONALLY CHEMICAL	FREQUENTLY SMELLS POLLUTED
NTAK INYANG 1	29	5	5	7	7	5
NTAK INYANG 2	30	3	2	8	9	8
NTAK INYANG 3	30	4	3	9	5	9
NTAK INYANG 4	29	5	4	10	6	4
MBIAKONG 1	30	1	6	8	8	7
MBIAKONG 2	31	7	5	6	8	5
MBIAKONG 3	31	5	6	7	8	5
MBIAKONG 4	31	4	9	4	9	5
EKPRI NSUKARA1	33	6	6	9	8	4
EKPRI NSUKARA2	33	5	8	5	6	9
EKPRI NSUKARA 3	34	4	9	8	9	4
EKPRI NSUKARA 4	34	6	8	6	9	5
TOTAL		55	71	87	92	70
Percentage (%)		14.67	18.93	23.2	24.53	18.77

Source: Ministry of Science and Technology, Uyo, Akwa Ibom State (2025)

**SW: Surface Water, GW: Ground Water*

Solids) and Hardness share the top rank signifying that TDS and Hardness are the most prominent water quality issues in the Ikpa River. High TDS levels, indicated by their substantial mean of 88.52, can make water unpalatable, reduce its suitability for irrigation and industrial uses, and potentially harm aquatic life by affecting osmotic balance WHO (2011). Similarly, high Hardness (mean of 88.52) primarily caused by dissolved calcium and magnesium, can lead to scale formation in pipes and appliances, reduce the effectiveness of soaps, and have minor effects on aquatic ecosystems at very high concentrations. Their consistent high ranking across different sampling points underscores its widespread presence and significant influence on the river's water quality.

2nd Position: Chloride: With a rank 1 position of 2nd and a mean of 26.15, Chloride represents the next most significant

pollutant. If Chloride level is elevated in water, it can result from natural sources, industrial discharge, or sewage contamination. High chloride levels can impart a salty taste to water, making it unsuitable for drinking and irrigation, and can also be corrosive to metal pipes and infrastructure Wang (2004)

3rd Position: pH: Ranking third with a mean around 6.55, pH indicates the acidity or alkalinity of the water. While the mean suggests a slightly acidic to neutral condition, fluctuations or values outside the acceptable range (typically 6.5-8.5 for aquatic life) can be detrimental. Low pH (acidic) can mobilize heavy metals from sediments, harming aquatic organisms, while high pH (alkaline) can also be toxic to certain species. The variability in the "Ranks" column (ranging from 5.95 to 7.30) suggests potential instability in the river's pH.

4th Position: E.coli: The presence of E.coli, indicated by a final position of 4th and a mean around 5.01 (note that E.coli is often measured as presence/absence or colony-forming units, so the mean here likely represents a transformed value for ranking), is a critical indicator of faecal contamination. E.coli itself may not be directly harmful in all strains, but its presence suggests the potential presence of other pathogenic microorganisms that can pose significant health risks to humans through direct contact or consumption of contaminated water Ewusi (2022).

5th Position: Phosphate: Ranking fifth with a mean of 2.78. Elevated Phosphate levels often originate from agricultural runoff containing fertilizers and domestic wastewater. While phosphorus is a nutrient essential for plant growth, excessive amounts can lead to eutrophication – the overgrowth of algae and aquatic plants. This can deplete dissolved oxygen levels, harming or killing fish and other aquatic life, and negatively impacting water clarity and odour (Oklahoma State University fact sheet (PSS-2917)

6th Position: Nitrate: With a sixth position and a mean of 1.53, Nitrate is another nutrient that, in excessive quantities (often from agricultural runoff and sewage), can contribute to eutrophication, similar to phosphates. High nitrate levels in drinking water can also pose health risks, particularly to infants (blue baby syndrome Tilman and Nekola (1999).

7th Position: Sulphate is ranking seventh with a mean of 1.34. High Sulphate concentrations can occur naturally or from industrial discharges (e.g., mining). Elevated sulphate levels can contribute to a bitter taste in water and, at very high concentrations, can have laxative effects. In anaerobic conditions, sulphate can be reduced to hydrogen sulfide, producing a characteristic "rotten egg" odor Jaishanka. (2014).

8th Position: Faecal Coliforms: Similar to E.coli, the presence of Faecal Coliforms (ranking 8th with a mean around 1.17 indicates faecal contamination and the potential presence of disease-causing microorganisms. While the mean is lower than E.coli, its presence still signals a risk to public health.

9th Position: Total Coliforms: Ranking ninth with a mean approximately 0.99, Total Coliforms are a broader group of bacteria, and their presence indicates potential contamination, although not necessarily faecal. High levels suggest a breakdown in water treatment or contamination from environmental sources.

10th Position: Nickel: With a 10th position and a mean around 0.91, Nickel is a heavy metal that can enter water bodies through industrial discharges and corrosion of metal components. At elevated concentrations, nickel can be toxic to aquatic life and pose health risks to humans through ingestion.

11th Position: Iron ranking eleventh with a mean 1, Iron is a naturally occurring element but can also enter water through industrial discharge and corrosion. High iron levels can cause staining of laundry and plumbing fixtures, impart a metallic taste to water, and contribute to the growth of iron bacteria, which can cause taste and odor problems.

12th Position: Lead: Despite having a relatively low mean of 0.03, Lead's final position of 12th is significant due to its high toxicity, even at low concentrations. Lead contamination typically occurs from the corrosion of lead-containing pipes and plumbing materials. It is a neurotoxin that can cause severe health problems, particularly in children. Even low levels of lead are a serious concern for water quality and public health.

Table 5: Comparative Analysis of the Ground Water in the Study Area with WHO Standard

PARAMETERS	GW- Ekpri Nsukara	GW- Ntak Inyang	GW-Mbiakong	MEAN	STDEV	WHO LIMIT
PH	6.03	6.663	5.95	6.214333	0.39061	6.5-8.5
TDS mg/l	73.4	38.7	104	72.03333	32.67145	500
Hardness mg/l	80	100	130	103.3333	25.16611	500
Chloride mg/	23.4	17.1	13.5	18	5.010988	250
Nitrate mg/l	1.181	1.811	1.104	1.365333	0.387874	45-50
Sulphate mg/l	0.981	1.183	0.735	0.966333	0.22436	200-400
Phosphate mg/l	2.148	1.738	1.248	1.711333	0.450592	
Lead mg/l	0.014	0.153	0.196	0.121	0.095126	0.5
Nickel mg/l	1.132	0.343	1.017	0.830667	0.426228	0.05
Iron mg/l	0.644	0.713	0.543	0.633333	0.0855	1
E.coli cfu 1/100ml	3	4	2	3	1	0
Total Coliform cfu 1/100ml	1	0	1	0.666667	0.57735	0
Feacal coliform cfu 1/100ml	1	1	1	1	0	0

Source: Researcher's construct from laboratory result (2025)

The groundwater samples from Ekpri Nsukara, Ntak Inyang, and Mbiakong exhibit a mixed compliance profile with WHO drinking water guidelines, presenting both satisfactory and concerning aspects.

pH: Regarding **pH**, the mean value of 6.21 is slightly below the WHO minimum acceptable range of 6.5-8.5. Specifically, Ground water -Ekpri Nsukara had 6.03 level and Ground Water in Mbiakong had 5.95 level of pH which is a fall outside this optimal range, indicating the water is somewhat acidic. While not immediately toxic, this could lead to corrosion of plumbing and affect aesthetic qualities.

For general water quality indicators, the groundwater appears to be in good standing.

Total Dissolved Solids (TDS) and **Hardness** have mean values of 72.03 mg/l and 103.33 mg/l, respectively, both significantly lower than the WHO limit of 500 mg/l. This suggests that the water is not excessively mineralized and is soft to moderately hard.

Chloride concentrations (mean 18 mg/l) are well below the WHO limit of 250 mg/l, and **Sulphate** levels (mean 0.966 mg/l) are also far below the WHO range of 200-400 mg/l

Nitrate levels, with a mean of 1.365 mg/l, are very low compared to the WHO guideline of 45-50 mg/l, which is generally a positive indicator, though extremely low levels can sometimes point to other environmental factors.

Lead: However, several parameters raise significant concerns. While the **Lead** concentration has a mean of 0.121 mg/l is below the WHO limit of 0.5 mg/l. The most striking deviation is observed with **Nickel**, where the mean concentration of 0.831 mg/l drastically exceeds the WHO guideline of 0.05 mg/l. All three groundwater samples show alarmingly high nickel levels, with GW-Ekpri Nsukara at 1.132 mg/l and Ground Water -Mbiakong at 1.017 mg/l representing particularly severe non-compliance, being over twenty times the limit.

Iron: Iron levels with a mean of 0.633 mg/l, are below the WHO limit of 1 mg/l, suggesting it is generally acceptable in this regard. Most critically, the presence of **microbiological contamination** renders this groundwater unsafe for direct consumption. The WHO standard for **E.coli, Total Coliform, and Faecal Coliform** is 0 cfu/100ml. However, the data consistently shows the presence of these bacteria. The mean for E.coli count is 3 cfu/100ml, with individual samples ranging from 2 to 4 cfu/100ml. Total Coliforms have a mean of 0.67 cfu/100ml, and Faecal Coliforms show a mean of 1 cfu/100ml, present in all samples. The presence of any coliforms, especially E.coli and Faecal Coliforms, indicates recent fecal contamination and a high risk of waterborne pathogens.

In summary, while the groundwater generally shows good quality for parameters like TDS, hardness, chloride, sulphate, and nitrate, the low pH, the high levels of Nickel, and critically, the undeniable presence of E.coli and other

coliform bacteria, indicate that this groundwater is **not fit for human consumption** without extensive treatment, particularly disinfection to eliminate microbial contaminants and potentially treatment for heavy metals.

4.2: Discussion of Findings

Result of the study shows that within Ikpa River Basin the dominant anthropogenic activities within the basin are agriculture (farming), resource extraction (sand mining and quarrying), and industrial/commercial activities (mechanic workshops and palm oil processing). Each of these activities carries specific potential environmental impacts that need to be further investigated to understand their cumulative effect on the Ikpa River ecosystem. The most dominant anthropogenic activity within the Ikpa River basin, as indicated by the questionnaire data is agriculture (farming). Farming with 140 individuals representing 37.33% of the surveyed population, stands out as the most prevalent activity. This suggests significant agricultural practices within the basin, potentially impacting water quality through fertilizer and pesticide runoff, as well as land use changes leading to erosion and sedimentation.

Following farming was quarrying, involving 62 respondents (16.53%), which also represents a significant extractive industry within the basin. Quarrying operations often involve the removal of large amounts of rock and soil, which can contribute to sedimentation, habitat loss, and potential contamination of water sources through dust and chemical runoff. Sand mining engaged 61 respondents (16.27%) indicates substantial extraction of sand resources from the river or its surroundings. This activity can lead to riverbed degradation, altered flow patterns, increased turbidity, and habitat destruction, directly affecting the aquatic ecosystem.

Next was Palm oil processing, involving 57 respondents (15.20%), indicates agro-industrial activity within the area. Palm oil processing can generate significant wastewater containing organic matter and nutrients, which, if not properly managed, can lead to water pollution and oxygen depletion in the Ikpa River. Finally, Mechanic workshops, with 55 respondents (14.67%), suggest the presence of automotive repair and maintenance activities. These can introduce pollutants like oil, grease, heavy metals, and solvents into the environment, potentially contaminating surface and groundwater within the river basin.

In conclusion, the dominant anthropogenic activities within the Ikpa River basin, as indicated by the occupational data, are agriculture (farming), resource extraction (sand mining and quarrying), and industrial/commercial activities (mechanic workshops and palm oil processing). Each of these activities carries specific potential environmental impacts that need to be further investigated to understand their cumulative effect on the Ikpa River ecosystem.

4.2.2 The Likely Pollutants Released by the Anthropogenic Activities.

Based on the ranking in Table 4. 16, Total Dissolved Solids (TDS) and Hardness emerge as the pollutants with the highest overall rank and is therefore considered the most significant pollutant released into the Ikpa River water. TDS and Hardness achieved a rank of "1st position" indicating they consistently exhibit the highest levels or impact among the measured pollutants. This is further emphasized by their mean value of 88.52, which is substantially higher than the means of many other pollutants listed. The "Order of Ranking" column also consistently places TDS and Hardness at the top, reinforcing their dominance as key water quality parameter of concern in the Ikpa River. Elevated TDS and hardness levels can stem from various sources, including agricultural runoff containing salts and fertilizers, industrial discharges, and domestic wastewater. High concentrations of dissolved solids can negatively affect the portability of water, alter its taste, and impact aquatic life by disrupting osmotic balance. Furthermore, increased TDS can contribute to the corrosion of pipes and infrastructure. The consistent top ranking of TDS and hardness across the different sampling points and their high average concentration strongly suggest that they are pervasive and significant forms of pollution impacting the Ikpa River ecosystem, warranting immediate attention and targeted mitigation strategies to improve the overall water quality. The sheer magnitude of their presence, as indicated by the high mean value and consistent first-place ranking, underscores the urgent need to identify and control the sources contributing to the elevated TDS and hardness levels in the Ikpa River.

In summary, the ranking highlights that TDS and Hardness are the most pervasive issues impacting the Ikpa River's water quality in terms of overall concentration and consistency. However, the presence of E.coli and Faecal Coliforms indicates significant faecal contamination and poses immediate health risks. While present in lower concentrations according to the means, pollutants like Lead are highly toxic and require careful monitoring due to their severe health implications. Understanding the position and the nature of each pollutant is crucial for developing targeted strategies to improve the water quality of the Ikpa River.

For Total Dissolved Solids (TDS) and Hardness, the mean values of 87.73 mg/l and 116.67 mg/l, respectively, are significantly below the WHO limits of 500 mg/l. This indicates that the water is not excessively mineralized and is considered soft to moderately hard, which is generally desirable. Similarly, Chloride concentrations, with a mean of 47.47 mg/l, are well within the 250 mg/l WHO limit, indicating no immediate concern regarding salinity. Sulphate levels, averaging 1.455 mg/l, are also comfortably below the WHO range of 200-400 mg/l.

However, significant deviations from WHO standards are observed in other critical parameters. Nitrate levels, with a mean of 2.044 mg/l, are alarmingly low compared to the

WHO guideline of 45-50 mg/l. While a lower nitrate concentration is generally preferred, this could potentially indicate other issues or specific environmental conditions. The heavy metal like Lead (mean 0.121 mg/l) shows values that are lower than the WHO limit of 0.5 mg/l)

Nickel presents a significant public health risk, with a mean concentration of 1.142 mg/l, drastically exceeding the WHO limit of 0.05 mg/l across all sampling points. The highest reading is from Surface Water Ekpri Nsukara at 1.51 mg/l, which is thirty times the permissible limit. Iron also exceeds the WHO standard of 1 mg/l, with a mean of 1.104 mg/l and the highest value recorded at Surface Water Mbiakong (1.318 mg/l).

Finally, the most critical issue is the microbiological contamination. For E.coli, Total Coliform, and Faecal Coliform, the WHO standard is 0 cfu/100ml, indicating that these organisms should be entirely absent in drinking water. However, the data shows mean values of 6.33, 0.33, and 1.67 cfu/100ml respectively, with individual samples for E.coli ranging from 5 to 8 cfu/100ml. This presence of coliform bacteria unequivocally indicates faecal contamination, posing a severe risk of waterborne diseases.

In conclusion, while some parameters like pH, TDS, Hardness, Chloride, and Sulphate, Lead meet WHO standards, the elevated levels of Nickel and Iron, alongside the undeniable presence of E.coli, Total Coliform, and Faecal Coliform, indicate that the surface water from these locations is not safe for human consumption without extensive treatment. Immediate intervention and appropriate water treatment measures are necessary to bring the water quality to acceptable WHO standards, particularly regarding heavy metals and microbial contamination.

5.2 Conclusion

This study revealed that farming activities, sand mining, mechanic workshop, quarrying and palm oil processing are the most dominant anthropogenic activities around Ikpa River Basin. Total dissolve solid (TDS), pH, Hardness, Chloride, Nitrate, Sulphate and Lead are variables within the permissible WHO limit, while Nickel, Iron, E coli, Total Coliform and Faecal Coliform on Ikpa river are variables above the permissible limit. The study also revealed that farming activities, quarrying and sand mining significantly affect the water quality of Ikpa River Basin. In view of these aforementioned, sustainable water treatment, proper management and environmental development should be ensured because failure to protect the quality of water from pollution will automatically destroy the water which will jeopardize the possibility of the future generation benefiting from it.

5.3 Recommendations

In view of the foregoing, there are needs for further investigation on the dominant anthropogenic activities in Ikpa

River basin because each of the activity carries specific potential environmental impacts.

Secondly, there are needs for Akwa Ibom state government to provide adequate or reliable public water infrastructure in the area, so as to mitigate the challenges associated with accessing centralized treated water sources.

Finally, due to the elevated levels of some parameters as stated in this study, in Ikpa River basin, immediate intervention and appropriate water treatment measures are necessary to bring the water quality to acceptable WHO standards, particularly regarding heavy metals and microbial contamination. Quality assurance measures should also be put in place to ensure safety and compliance. This should include environmental protection exercise, Quality assurance exercise and enlightenment campaigns to reduce the level of anthropogenic activities in the river basin.

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